# Status of ELM Simulating Plasma Gun

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# Outline

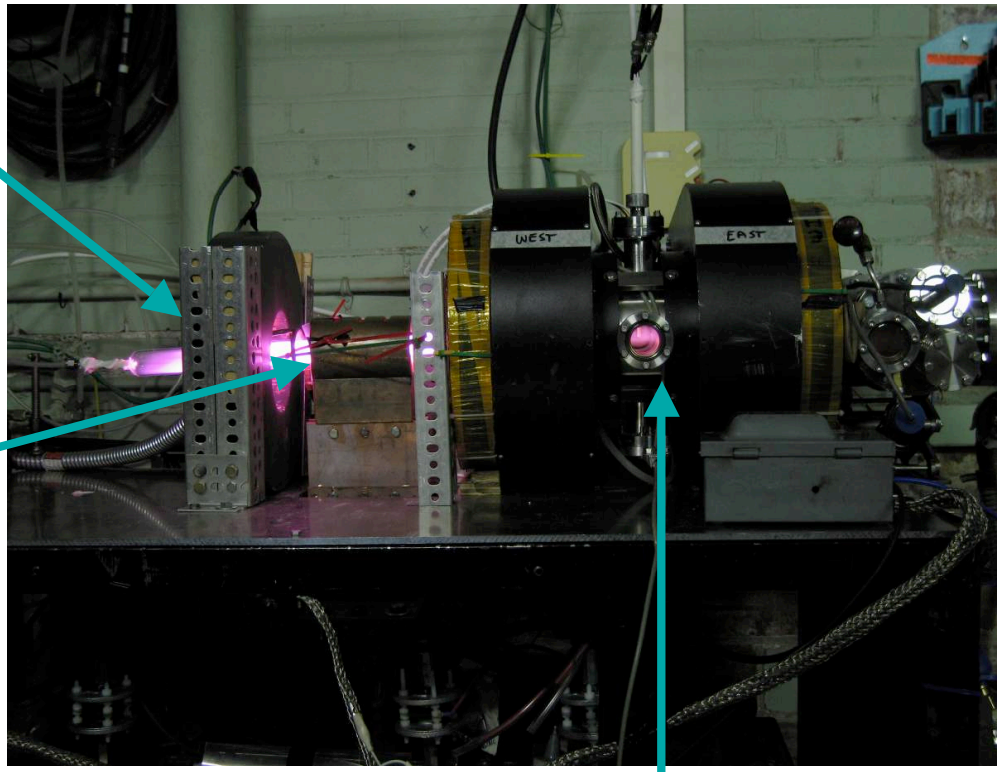
- Overview of current ESP-gun machine
  - Pulse forming network, pre-ionization source, diagnostics
- Magnetic Field Topology
- Electrical Characteristics
- Plasma Parameters
- IR Measurements
- Summary

# Introduction and Goals

- Type 1 Edge Localized Modes
  - 10 MW/m$^2$ on diverter surfaces
  - Create heat loading problem
  - Create debris and impurities from the diverter
- ESP-gun
  - Laboratory machine to reproduce ELM plasmas
  - Test heat loading and material properties under a simulated, laboratory ELM plasma

# ESP-gun

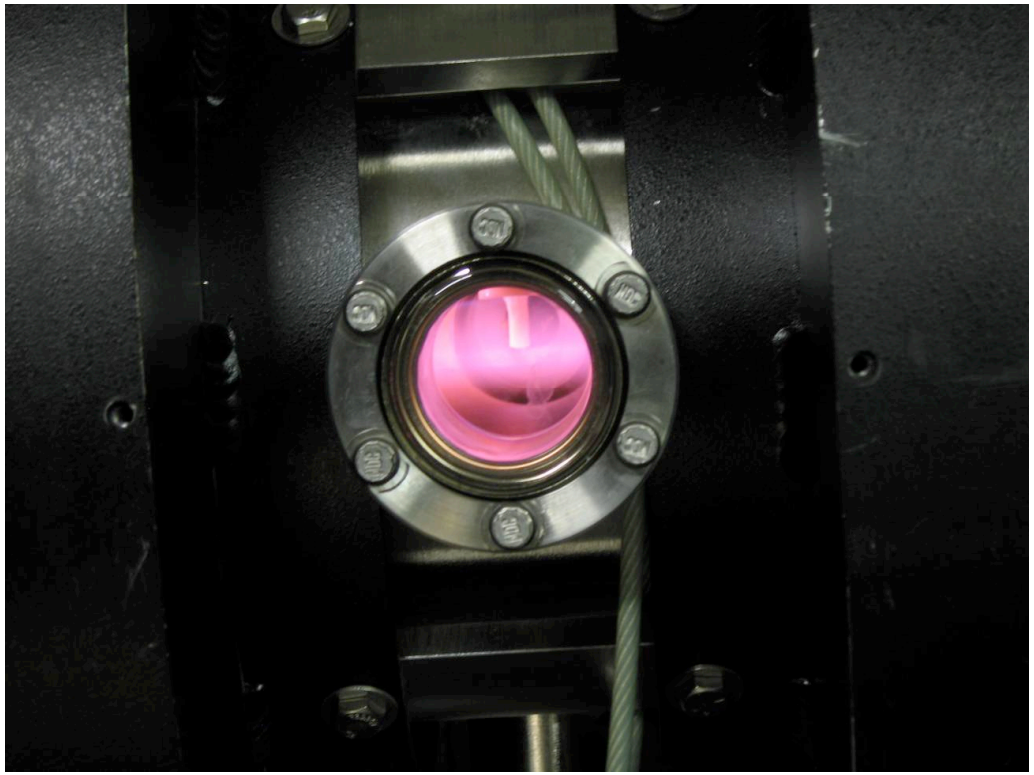
- RF pre-ionization source
- ECR magnets for down stream field
- Conical, theta coil
  - ~ 5º taper




Target Area

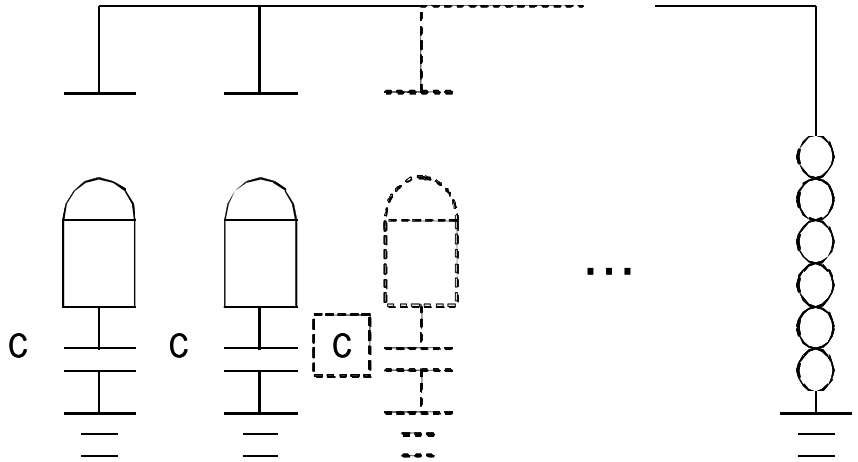
# Diagnostics - presently

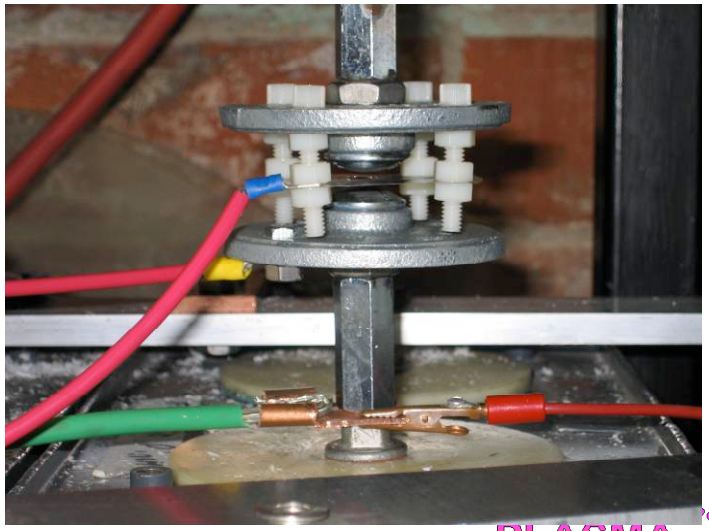
- High Voltage, high bandwidth probe
- Rogowski Coil
- Optical Emission Spectroscopy
- Electric Probes



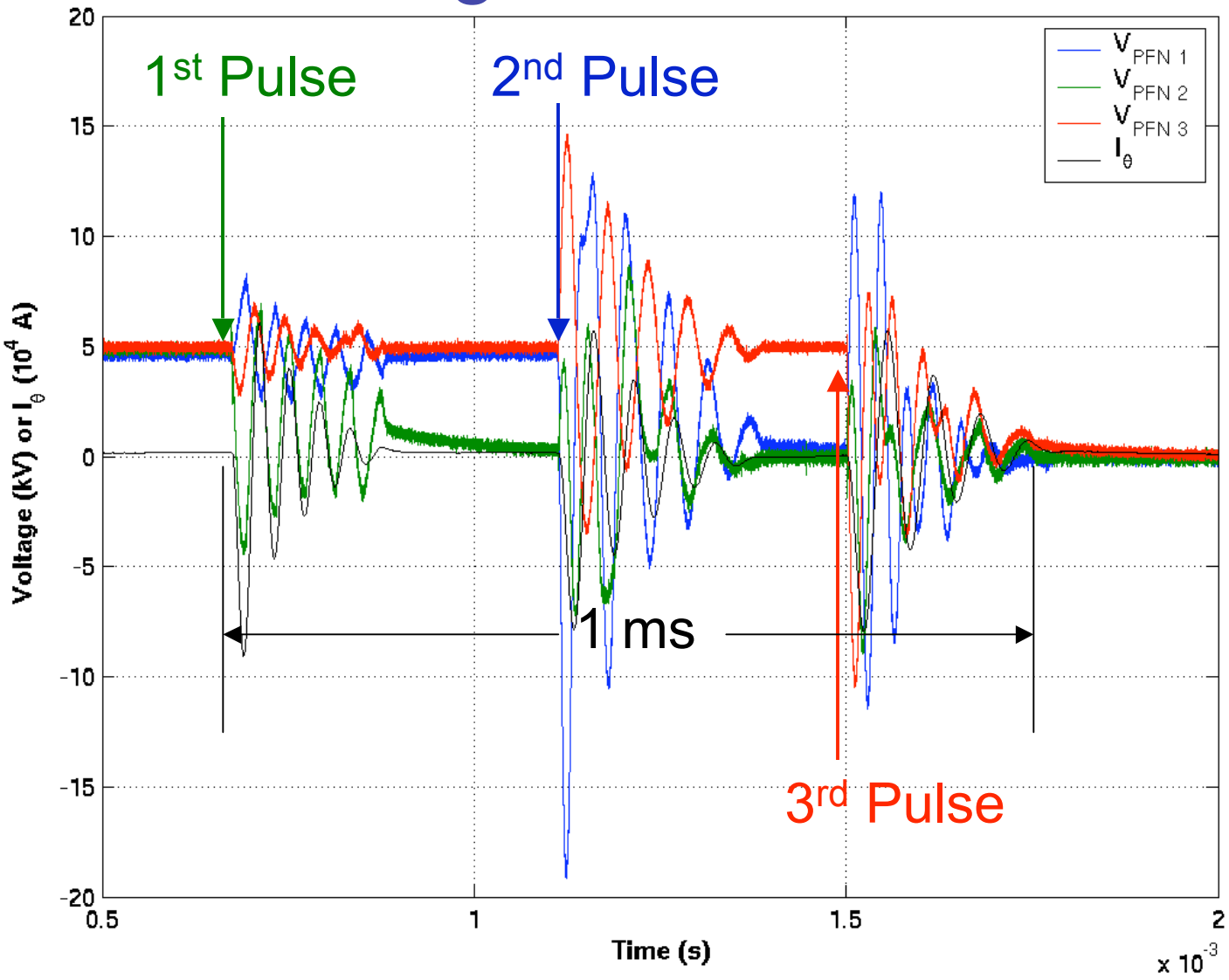
# Pulse Forming Network

- 3 smaller PFN's
  - 55 μF, 500 nF Capacitor
    - 6 kJ total energy storage capacity
  - Low inductance transmission lines
  - ~ 100 kHz frequency
- Triggered Spark Gaps
- Each PFN is independently triggered



# Voltage and Current



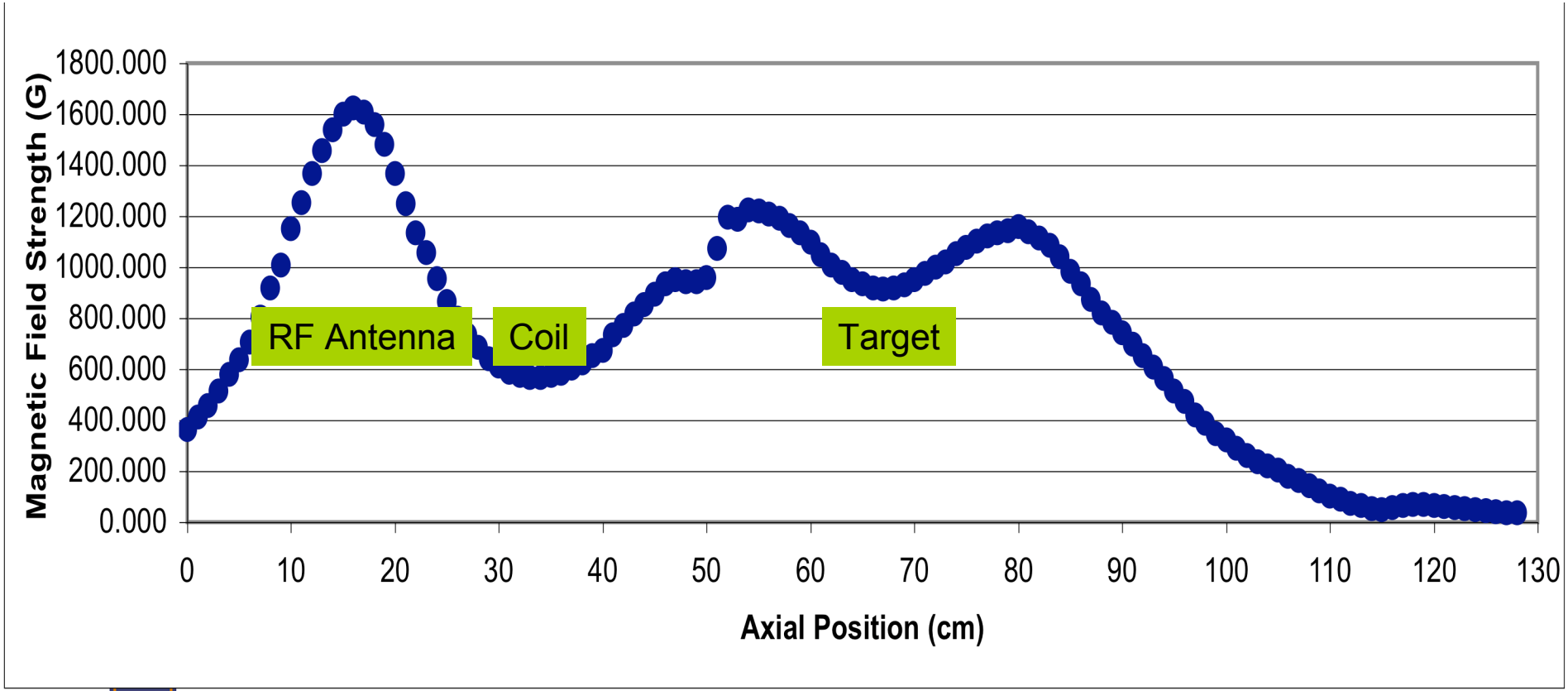
# PFN Results and Improvements

- 10 - 50 kA peak coil currents
- 250 μs total pulse length per PFN
- Rise time, λ/4 ~ 13 - 16 μs

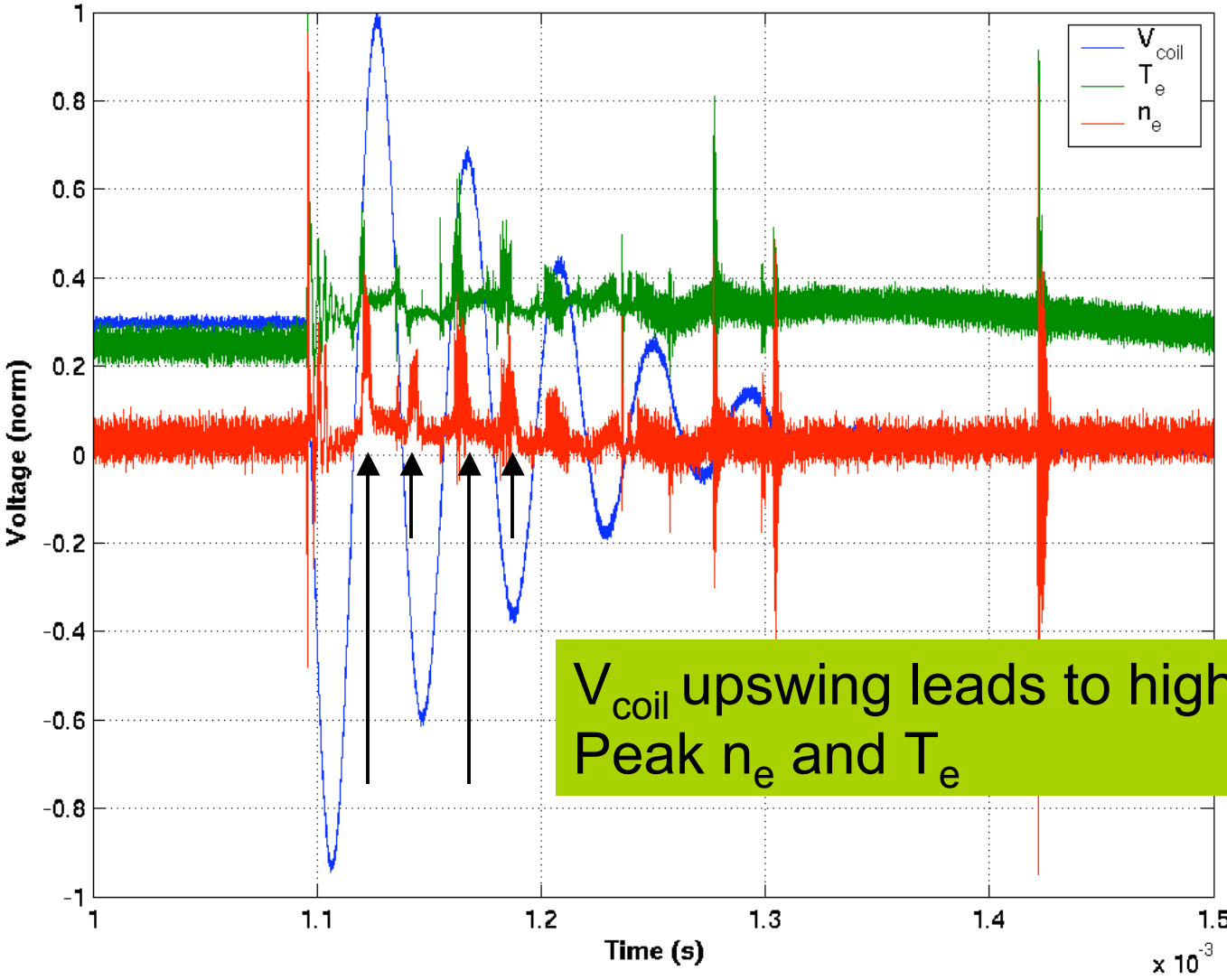
- $L_{PFN}$ = 500 nH (cap inductance)
  - λ/4 is limited by caps!!!

# Magnet Field Topology

## ~ 990 G on target

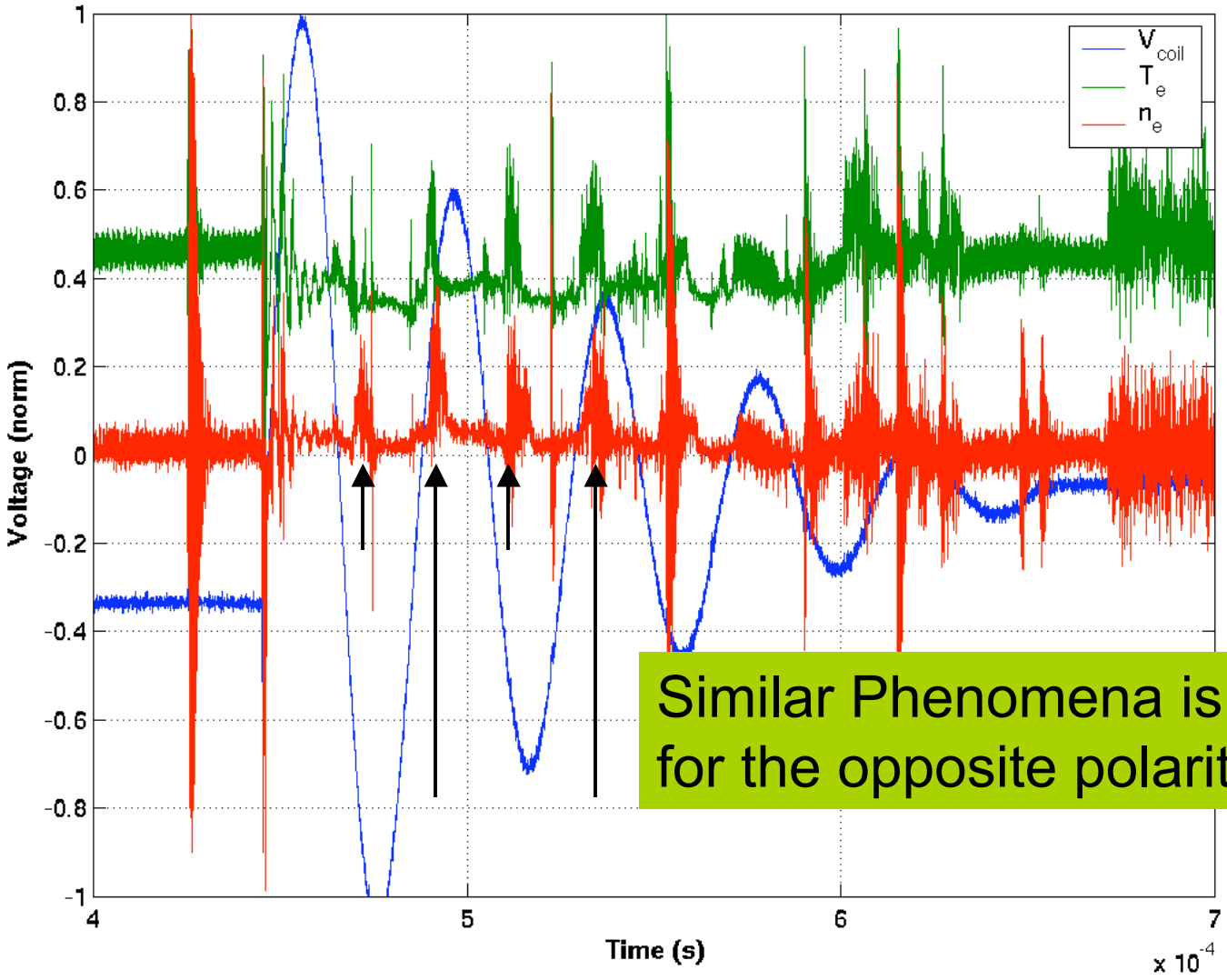


# Typical TLP Trace




$V_{coil}$ upswing leads to higher Peak $n_e$ and $T_e$

# Negative Charge




Similar Phenomena is seen for the opposite polarity

# Plasma Behavior

- Upswing of the voltage
  - $B_{coil}$ aligned with $B_{ext}$
- Downswing of the voltage
  - $B_{coil}$ reversed with respect to $B_{ext}$
- Field Reversed Configuration (FRC) ?

# Flow Velocity

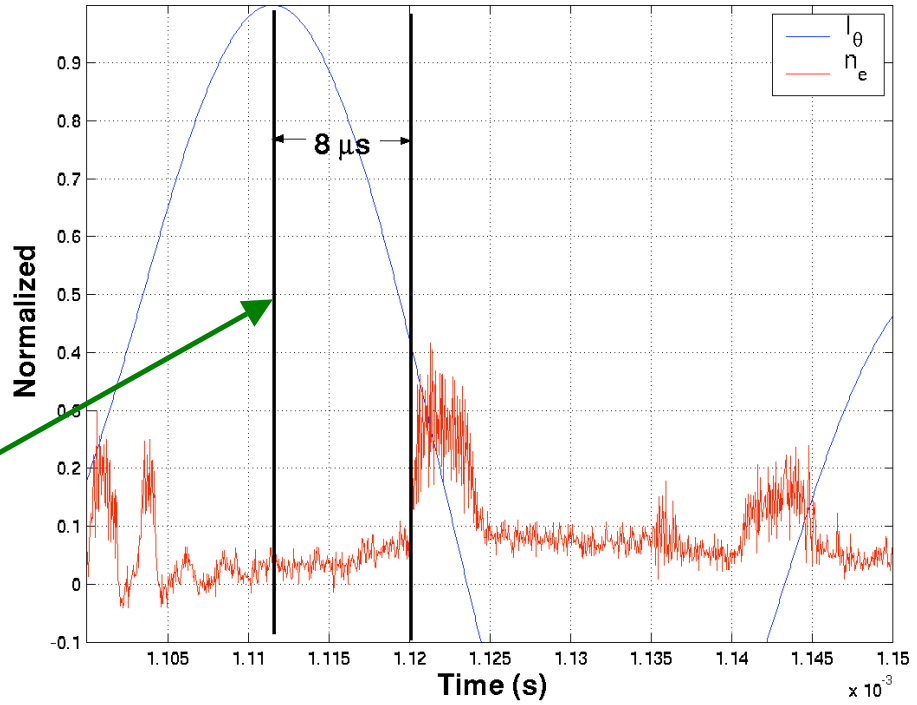
- Estimate v from time of arrival of $n_e$

  $\langle x \rangle$ = 36 cm

  $\langle v \rangle = 4.5(10)^4$ m/s

- $\langle v \rangle \sim v_{th}$

$I_{max}$, V=0



# Summary

- Pulse Forming Network
  - 50 kA, 250 μs per PFN
  - Multiple (3) PFNs → pulse length ~ 1ms
- Peak Plasma Parameters (at 50 kA, 2kJ in)
  - $n_e \sim 1(10)^{18}$ /m$^3$
  - $T_e \sim 15 - 20$ eV
  - $\langle v \rangle = 4.5(10)^4$ m/s
- Possible FRC Formation

# Acknowledgements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